FORESTRY RESEARCH
WHAT'S NEW IN THE WEST
U.S. Department of Agriculture Forest Service

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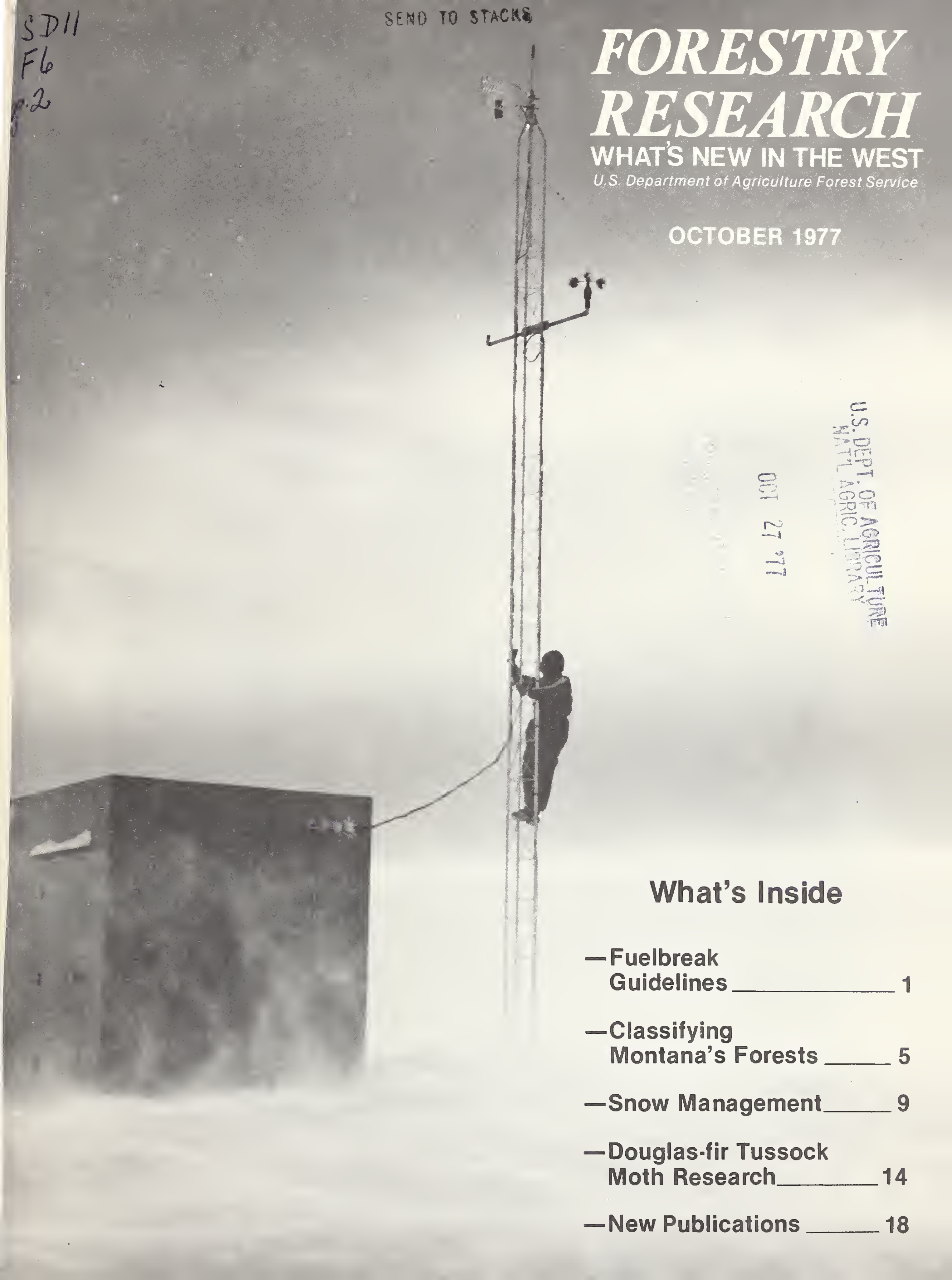

What's Inside

a note to you

Forestry Research: What's New in the West, is a report on the work of the USDA Forest Service's four Forest and Range Experiment Stations in the West. These research centers, and the States included in their areas of study are: Rocky Mountain (North Dakota, South Dakota, Nebraska, Kansas, Colorado, Arizona, New Mexico, and part of Wyoming, Oklahoma, and Texas); Intermountain (Montana, Idaho, Utah, Nevada, and part of Wyoming); Pacific Northwest (Alaska, Oregon, and Washington); and Pacific Southwest (California, Hawaii, and the Pacific Basin).

on the cover

Snow Scientist Ron Tabler checks a Weather Monitoring Station, developed by the USDA Forest Service, near Wyoming's Interstate 80. Weather data is relayed to the Wyoming Highway Department for use in making decisions for regulating traffic. See "Snow Management" on page 9.

our addresses

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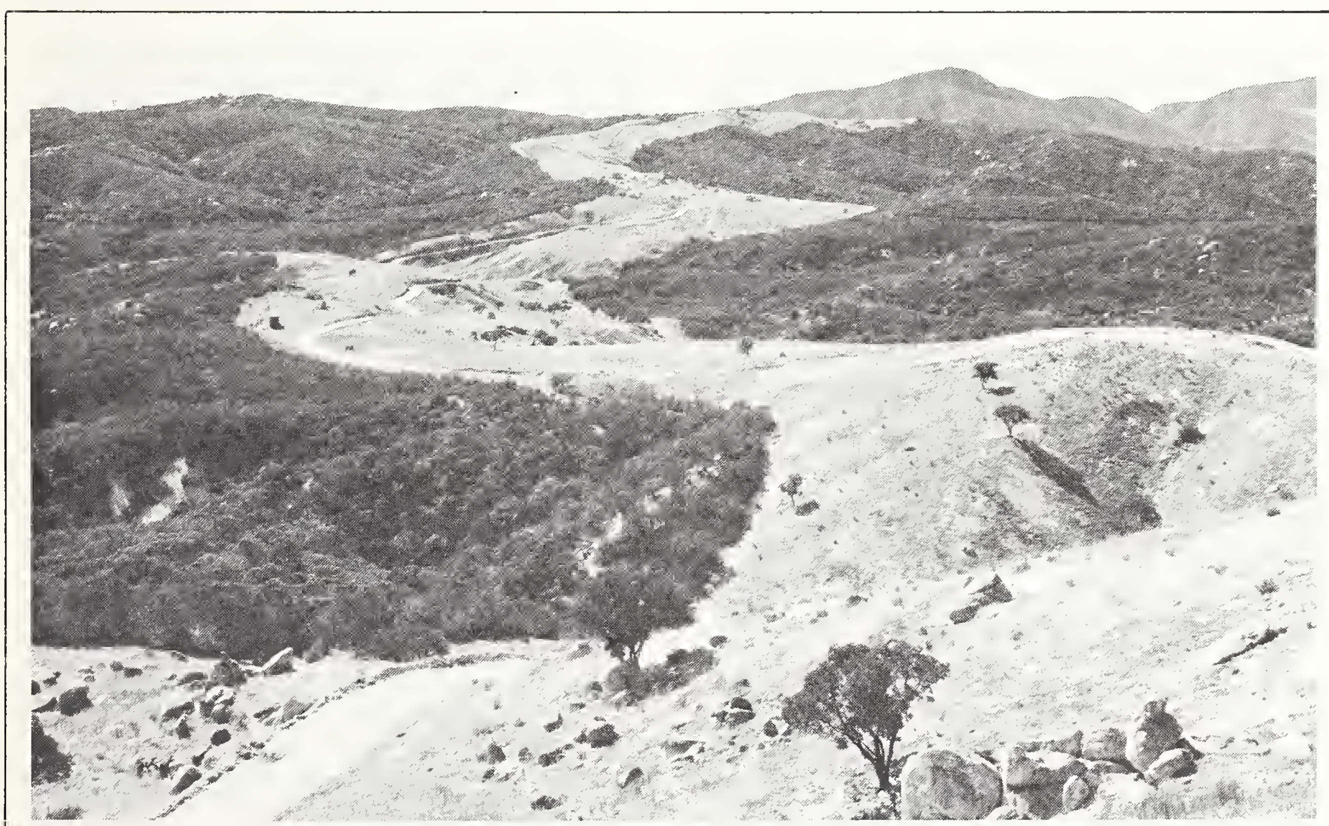
Researchers develop fuelbreak guidelines

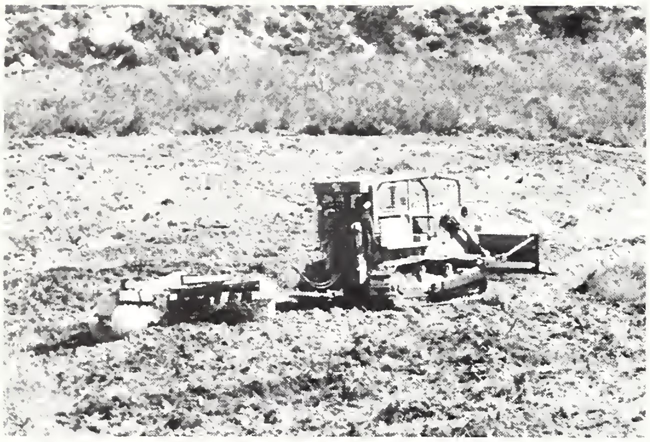
More than 2,000 miles of fuelbreaks wind along ridgetops, roads, and canyon bottoms in California wildlands. The fuelbreaks are usually at least 200 feet across — wide enough to provide a break, or opening, in heavy, dense forest or brushland vegetation. The grasses or shrubs growing in the fuelbreaks are "light fuels" — plants that are less of a hazard to firefighters than the thick, flammable vegetation growing beyond the fuelbreak borders.

Strategically located, fuelbreaks serve as ready-made fire control lines. They are access routes for firefighters and equipment, and relatively safe places to control a fire — either by fighting it as it burns towards the fuelbreak, or by starting a backfire out to meet the wildfire.

Fuelbreaks have other uses. They can serve as routes for vacationers, and, depending upon the plants growing in the fuelbreak, may provide food for wildlife or livestock.

A fuelbreak's usefulness during a wildfire may depend upon such factors as the fuelbreak location, and wind and fuel condition.





A large brushland disk, pulled by a tractor, will uproot, cut up, and mulch brush.

Over a 17-year period, researchers at the Pacific Southwest Station's Forest Fire Laboratory in Riverside, California, have conducted studies on almost every aspect of fuelbreak development and management. Representatives of the National Forests of California, California Department of Forestry, Los Angeles County Fire Department, Los Angeles State and County Arboretum, and other Federal, State, and County organizations have been cooperators in this research. Studies have covered the uses of fuelbreaks, their cost, design, construction, revegetation, and maintenance. Most of the research took place in southern California brushfields, but some dealt with fuelbreaks in conifer forests — mainly ponderosa pine.

The results of these studies are not limited just to California. Instead, they have useful implications for land managers in areas where the climate, terrain, and vegetation are similar to California's. Here are some highlights of this research:

The best way to plan fuelbreaks is on a large-scale basis. Complete fuelbreak systems — interconnected networks of individual fuelbreaks — should be mapped out, even if the money needed to construct the breaks isn't available at the time the plans are made. If they are well designed, fuelbreaks will not only meet the needs of firefighters, but will, within a few years after they are constructed, look like natural changes in the vegetation.

Clearing techniques

There are a variety of techniques that can be used to construct fuelbreaks. Brush growing in the path of a planned fuelbreak can be cleared by hand, by bulldozers or other machinery, by prescribed fire, or a combination of these. All of these methods have been tested at sites throughout California. Each has advantages and limitations. Hand clearing is the most expensive, and is slow, but may be the only available method where fuelbreak sites are too steep or too rocky for bulldozers or other machinery to navigate.

Machine clearing is faster and cheaper, but must be done carefully, so that erosion and sedimentation, an inevitable result of machine operations, will be minimal. In California wildlands, the most efficient machines to use are either a tractor with a bulldozer blade, or a tractor with heavy, offset disks. Of the two, the bulldozer is more versatile — it can be used on slopes up to 55 percent, while the disk is inefficient on slopes of more than 30 percent.

The cheapest way to dispose of brush debris is to burn it. In a bulldozing operation, brush can be crushed for later broadcast burning, or pushed into piles for later burning.

Two alternatives to burning — chipping debris or burying it — have been tried, but both are more expensive than burning.

After disking, burning is sometimes unnecessary. In most chamise stands, for example, two passes of the disk will be enough to chop and partially bury most of the vegetation.

Clearing brush by burning usually costs less than bulldozing and generally creates less soil disturbance. The disadvantages of prescribed burning include the possibility of escape and the associated liability, the smoke it produces, (although researchers claim the smoke is more of a nuisance than a pollutant), and the possibility of some undesirable side effects on the soil, such as burning of organic matter, destruction of soil organisms, and creation of a non-wettable layer in the surface soil.

Repeated, low-intensity prescribed fires are recommended for clearing fuelbreaks in pine forests. They can efficiently remove needles, cones, dead branches, and other fuel from the forest floor, without harming the overstory trees.

Chemical treatment

In brushfields, the studies have shown that the vegetation needs to be treated before burning, for best results. The brush should either be crushed, or be treated with chemicals that will dry it out (desiccants). If the brush fuels aren't treated, the prescribed fire is more likely to be uneven, and some patches of brush may not be burned.

Brittle-stemmed, mature brush can be crushed effectively by a bulldozer, an anchor chain pulled by two tractors working in concert, by a ball and chain pulled by one tractor, or by tractor-mounted rollers or drags. (Agricultural Handbook No. 487, "Mechanical Methods of Chaparral Modification," has details; copies are available from the Pacific Southwest Station.)

Young, flexible brush should be treated with desiccants. Two classes of desiccants — contact herbicides and systemic herbicides — have been studied. The contact herbicides quickly dry out leaves and small twigs; the systemics are slower acting and attack the plant internally. The chemicals PCP (pentachlorophenol) or DNBP (dinitro secondary butyl phenol) in diesel oil are the most cost-effective of the government-approved contact herbicides. Systemics such as 2,4-D or 2,4,5-T, or 2,4-D plus the herbicide picloram, cost less than the contact herbicides to apply, and usually result in a much more complete plant kill.

Applying herbicides — whether from the air, or from the ground by tractor-mounted or hand-carried boom sprayers — is the most effective way to prevent regrowth of unwanted plants. Regrowth is by far the biggest obstacle to successful establishment of fuelbreaks in California brushfields. This is because some brush species can resprout within 10 days after burning, and can be 8 to 10 inches tall a month later. For this reason, researchers recommend that herbicides to control brush regrowth be applied no later than 2 years after the initial clearing, and be followed by one or two more applications in the next few years. The most useful chemical for controlling regrowth is 2,4-D.

The fuelbreak cover, planted or seeded in place of the original vegetation, must meet several requirements. The fuelbreak plants should be slower to burn than the plants they have replaced; they should also help stabilize the soil, establish readily, reproduce well, and require little maintenance. Further, the plants should be low-growing and should be low in fuel volume — the weight of the new plants, plus the litter they produce, should be no more than 2 tons per acre, dry weight.

At the Forest Fire Laboratory, more than 50 species of native and foreign grasses and shrubs that showed promise of having most, or all, of these characteristics, were evaluated. Grasses were included in the research, for several reasons. Although firespread in grass is rapid, its behavior is predictable. Fire in chaparral is less predictable, and control is much more difficult. Furthermore, firefighters can use fast-moving grass fires to their advantage, by quickly "firing out" control lines in grass-covered fuelbreaks. Finally, grass adds only 2 to 3 tons of fuel per acre, while brush can add from 5 to 40 tons, per acre.

Certain conditions are required for aerial application of herbicides — winds should be under 5 miles per hour, the air temperature should be below 70 degrees F., and the humidity should be greater than 40 percent.

Creeping sage (foreground) was among the most successful shrubs in field tests of low-growing, slow-burning plants.

Fuelbreak cover

Perennial grasses are recommended over annuals, because perennials have a deeper root system, stay green further into the fire season, and are generally more stable. Of the perennials studied, intermediate and pubescent wheatgrasses are the most highly recommended.

Of the low-growing, woody shrubs available, bearmat is the best naturally occurring ground cover for fuelbreaks in conifer forests of the west-side Sierra Nevada. For brushland fuelbreaks, creeping sage is an excellent cover. It grows on a wider variety of chaparral sites than any of the other low-growing brushland shrubs tested. Like bearmat, creeping sage produces low, mat-like foliage that successfully crowds out herbaceous plants. Creeping sage can be established by seed (if the seeds are treated in gibberellic acid to break dormancy), or by cuttings or transplants.

Descanso rockrose is also highly recommended, because it is relatively drought-tolerant and is well-adapted to a wide range of sites. Although it can grow as high as 2 feet, it is a relatively low shrub, compared to other chaparral species. Mature rockrose is susceptible to fire when its moisture content drops in the late summer and fall; but, because of its relatively low height and low fuel volume, it burns with less intensity and less heat than most chaparral species.

Two tall shrubs — fourwing saltbush and allscale saltbush — are also recommended as fuelbreak cover. Fourwing saltbush is drought-tolerant, relatively cold-tolerant, and provides excellent browse. It can be established either from direct seeding or potted transplants, but should be enclosed during its first year, to keep out foraging rabbits. Allscale saltbush is also drought-tolerant and relatively cold-tolerant. It is a good browse for livestock and deer, and is easy to establish.

Fuelbreaks are not the ultimate answer to wildland fire management problems, but their value to firefighters has been proven throughout the State. Details about the fuelbreak studies described here are presented in two new publications — "Fuelbreaks and Other Fuel Modification for Wildland Fire Control," USDA Agricultural Handbook No. 499-FR12, by Lisle R. Green, and "Low-volume and Slow-burning Vegetation for Planting on Clearings in California Chaparral," Research Paper PSW-124-FR12, by Eamor C. Nord and Lisle R. Green. Copies of each are available from the Pacific Southwest Station.

By Marcia Wood, Pacific Southwest Station

Classifying Montana's forests

Forest site classifications based on habitat types are now used by land managers and researchers in more than 20 western areas.

"Forest Habitat Types of Montana," a general technical report published by the Intermountain Station, describes the first such classification based on a large-scale reconnaissance study. More than 1,500 stands in 10 National Forests were sampled to develop this habitat type classification for Montana's extensive forests.

The study was led by Robert Pfister, Project Leader of the Station's Forest Ecosystems research work unit, headquartered at Missoula. The Northern Region of the Forest Service provided major financial assistance, and the University of Montana's Forestry School and Botany Department provided administrative and technical support.

The Montana classification involved a progressive series of analyses by Pfister and his associates. Development included 4 years of field testing by land managers and researchers.

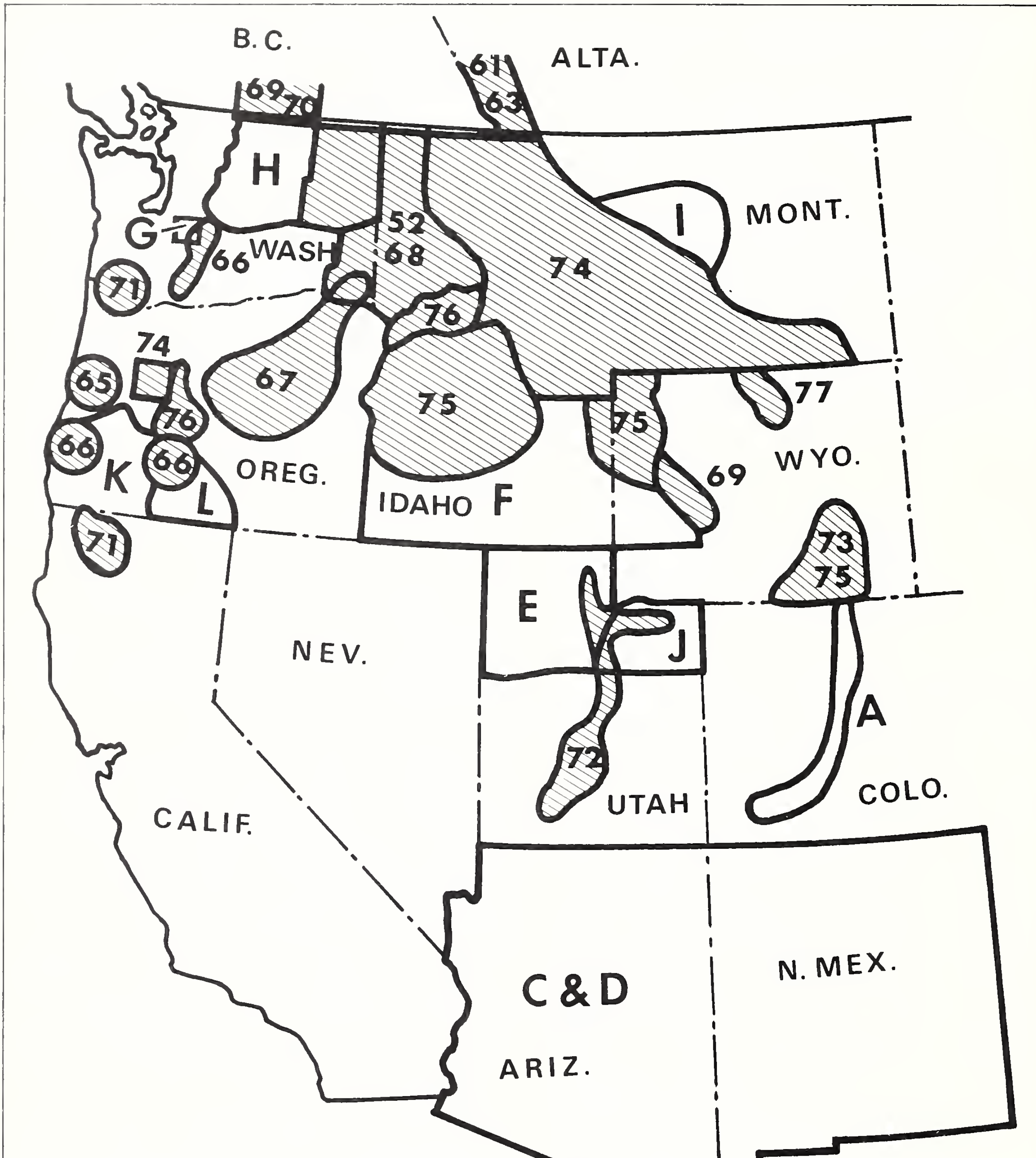
Habitat typing as an approach to forest ecosystem classification was originally developed for northern Idaho and eastern Washington by Professor Rexford Daubenmire of Washington State University. Daubenmire's system proved valuable, and it served as a model for classification work throughout western forests.

Habitat types are based on the potential climax tree and undergrowth vegetation for given sites. The theory is that climax vegetation, developing over long periods of time without disturbance, most clearly reflects environment and site characteristics.

Pfister explains that successional trends toward climax vegetation can usually be identified even in rather young stands. Thus a given habitat type includes all land areas potentially capable of producing similar plant communities when vegetation reaches climax, even though the present vegetation may be dominated by early successional species.

To represent Montana's diverse forest environments, Pfister and his team have defined 64 habitat types. However, only a few are found in specific drainages or mountain ranges, and they occur in a generally consistent and predictable local pattern related to topography.

A "key to habitat types," similar to the familiar keys for identifying plants, permits Montana foresters to identify types after minimal training. Numerous shortcourses have been conducted to help land managers effectively apply habitat typing concepts.



Status of forest habitat type classifications in western North America. Numerals refer to year in which classifications were completed. Letters refer to current studies.

The Classification Framework

Habitat types provide a simple, orderly classification system. The first part of each habitat type name is based on the climax tree species, which is usually the most shade-tolerant tree adapted to the site. This level of classification is called the series, encompassing all habitat types having the same dominant tree at climax. The second part of the habitat type name is based on the dominant or characteristic undergrowth species in the climax community type.

A third level, the phase, is used when necessary to recognize subdivisions of a habitat type — for example, the *Agropyron spicatum* (bluebunch wheatgrass) phase represents the warmest, driest part of the *Pseudotsuga/Calamagrostis* (Douglas-fir/pinegrass) habitat type.

Applying Habitat Types

Some current applications of habitat typing are:

HABITAT TYPE MAPPING — Habitat type maps can serve as a fundamental contribution to land-use planning. Maps at scales of 2 inches per mile have been prepared for several planning units, and also for some entire National Forests. Maps in greater detail have been prepared for project planning and research studies.

TIMBER MANAGEMENT — The Montana report provides timber productivity data for most habitat types. It also shows distributions and roles of tree species by habitat type. This helps silviculturists determine which species to plant or to favor in thinning or partial cutting. Habitat types are used in guidelines for seed collecting, selecting sites for planting nursery stock, categorizing sites in genetic tree-improvement programs, comparing regeneration success, and evaluating cutting methods.

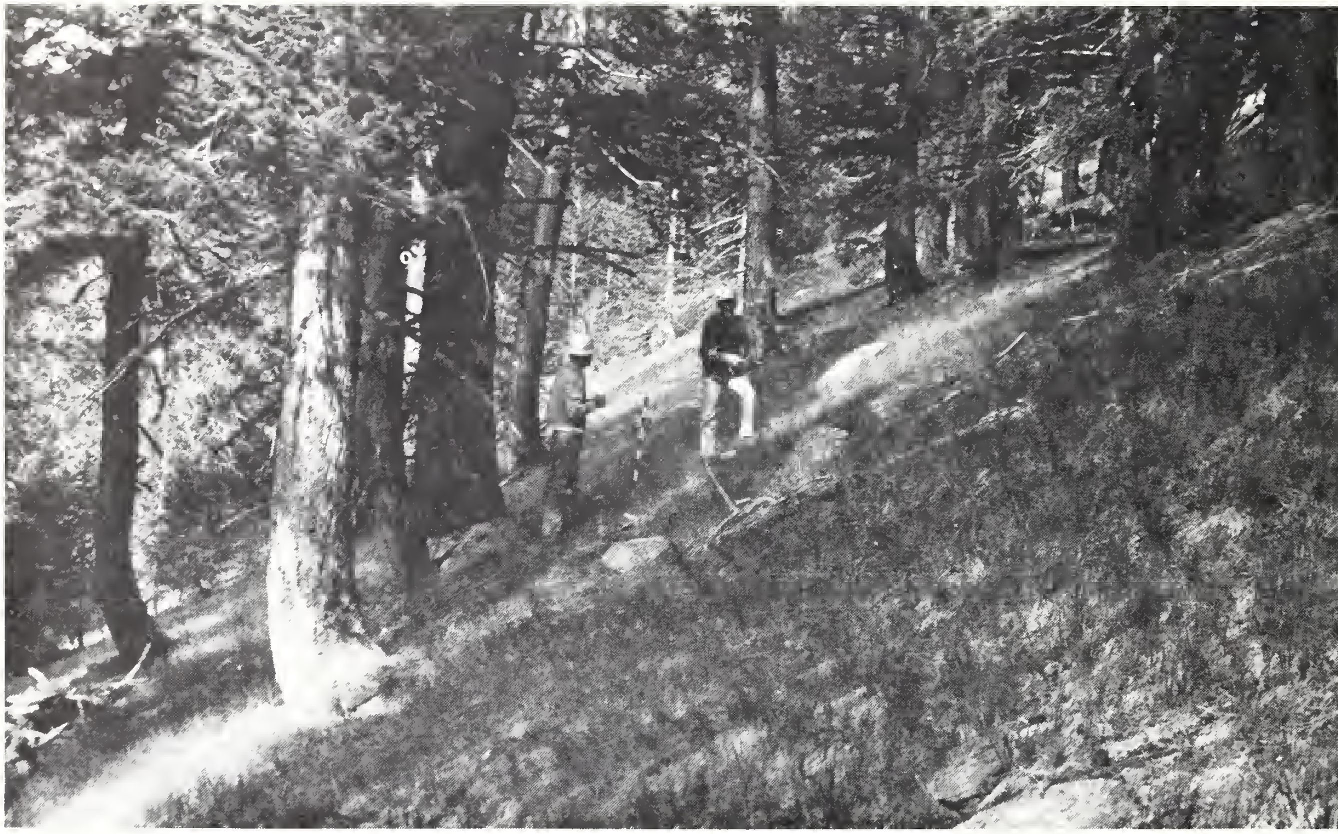
RANGE AND WILDLIFE MANAGEMENT — The report provides information on the frequency and abundance of all species — including important forage plants — in mature stands representing each habitat type. It also summarizes observations of use by domestic stock and wildlife in each type.

WATERSHED MANAGEMENT — Certain habitat types and phases are identified with seepage, subsurface water, or wet sites that require special considerations, particularly in specifying timber harvesting methods and roadbuilding. The Montana report gives climatic data for many types.

RECREATION MANAGEMENT — Habitat types have been used to assess suitability of sites for recreational use, evaluate impacts of use on plant communities and sites, and predict recovery rates following disturbance.

FOREST PROTECTION — Habitat types can be used in categorizing fuel buildup, developing fuel management plans, and evaluating the natural role of fire. They can also be used in assessing susceptibility of vegetation to insects and diseases.

Estimating coverage of undergrowth species in a plot.



Pseudotsuga menziesii/Calamagrostis rubescens *(Douglas-fir/pinegrass) is a habitat type that is widespread in Montana and adjacent western States and Canadian provinces.*

NATURAL AREA PRESERVATION — Habitat type information can help to insure that the environmental spectrum is adequately represented in a natural area system.

Pfister cautions that use of habitat types is not a panacea for land management decision-making or research interpretation. In many cases, however, they can provide a common frame of reference complemented by information on current vegetation, soils, and other site characteristics. The Montana classification is a major step toward the goal of developing and applying classification systems for management of forest ecosystems.

Pfister points out that further work must be done to fully realize the potential benefits of habitat types in land management. Continued support is needed to complete regional classifications. Cooperative research-management programs could use habitat type classifications to summarize and communicate existing knowledge from many disciplines. Classifications, or models, of successional vegetation within the habitat type framework are needed to serve many management purposes.

Authors of "Forest Habitat Types of Montana" (INT-GTR 34-FR12) are Pfister; Bernard L. Kovalchik, timber management planner on the Helena National Forest, Montana; Stephen F. Arno, associate plant ecologist of the Forest Ecosystems unit; and Richard C. Presby, forest biotic planning specialist on the Idaho Panhandle National Forests.

Copies of the report are available from the Intermountain Station.

Readers needing additional information should contact Robert Pfister in Missoula, Montana at (406) 329-3533, FTS-585-3533.

— By Delpha Noble, Intermountain Station

Snow management

Snowfall in the mountain West is often a real blessing. Mountain and plains communities and farms depend on the snowmelt for survival. Sometimes, however, snow can become a curse. Explosive development and increasing recreational activities have intensified two natural hazards of increasing importance — blowing snow and snow avalanches. Blowing snow creates visibility problems along transportation routes and often causes road closures — avalanches trap travelers and demolish valuable property.

Avalanches are of increasing concern to land managers and planners throughout the West. Avalanche accidents have been on the rise in recent years, due to the escalating development of ski resorts, private residences, roads and highways, and a general increase in outdoor recreational activities. Recorded avalanche accidents in recent years have taken an annual average of 12 lives and caused over ¼ million dollars in property damage and loss.

Various government and private groups throughout the country are involved in avalanche research. One is the Mountain Snow Management and Avalanche Hazard Evaluation Project located at the Rocky Mountain Station in Fort Collins, Colorado. Project Leader Mario Martinelli, Jr., says the mission of his unit is to find ways to minimize the hazard of avalanches to life and property.

Avalanches, such as this, are common in the mountains of the western United States. Most go unnoticed by man.

One problem of increasing concern is the development of second-home, resort, and retirement communities near or in avalanche paths and runout zones — the bottom boundary of an avalanche path. This concern is compounded by the general lack of a systematic approach toward land use planning in hazardous areas.

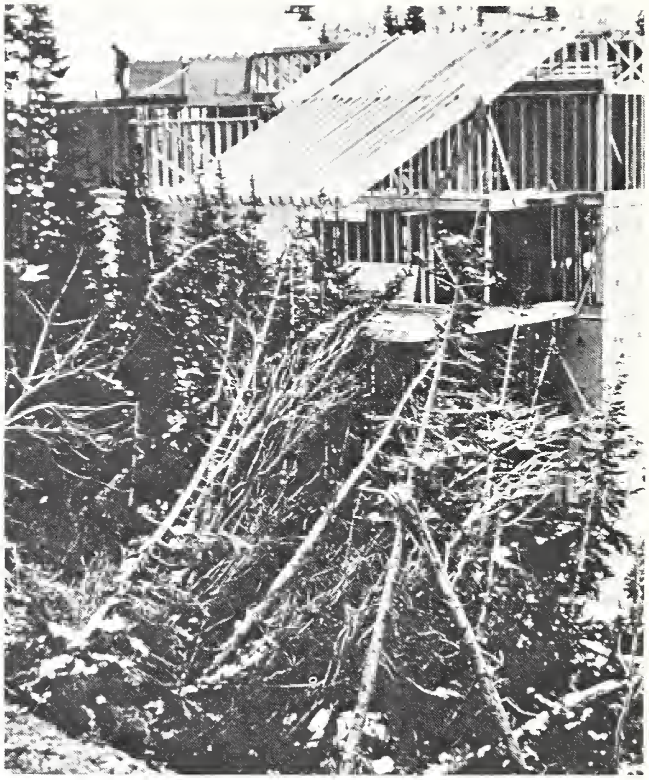
Station scientists have developed a system which combines early studies by European scientists with recent findings to produce formulas for predicting how far an avalanche will travel, its mass, and the impact force it will carry. These formulas, and direction for their use, will be of interest to government officials and private developers who have the responsibility of zoning and recreation planning in mountain areas.

Avalanche Warning System

In addition to zoning hazards, other problems result from winter recreation. In the backcountry, avalanche control measures, as might be used in developed ski areas or along highways, are nonexistant. Cross country skiers, winter hikers, and mountaineers are prime victims of avalanches in these areas.

In 1973, a joint venture between the National Weather Service and the Rocky Mountain Station resulted in an "Avalanche Warning System" to help evaluate current hazard conditions in Colorado's mountains, and to warn mountain residents and travelers when avalanche danger is high. Most avalanche activity is directly related to precipitation, wind speed, and other weather factors.

The Forest Service has established numerous weather reporting stations in critical avalanche areas. Information is collected by on-the-spot observers or by instruments that relay observations to automatic recording stations. These data, combined with snow conditions and weather reports from other government and private cooperators throughout the State, help researchers develop an up-to-date evaluation of potential avalanche activity in Colorado's mountains. Bulletins are issued to local media for broadcast to the public whenever avalanche danger exists.



Increased mountain development has placed some structures in or near avalanche paths. This condominium is going up directly in an area noted for avalanches. Note the dead and torn trees as a result of avalanche activity.

The "Avalanche Warning System" was designed to warn recreationists, such as these cross country skiers, of existing avalanche conditions before they enter into the backcountry.

Similar avalanche warning systems have been, or are being, organized in other western states.

Rocky Mountain Station researchers are also trying to improve their ability to predict when a given snowpack might release from a slope. Dick Sommerfeld, research geologist with the project, has placed recording sensors in the snow at Berthoud Pass, Colorado, an area notorious for large and frequent avalanches. Results from this study are still being evaluated. Indications are that prior to an avalanche, the snow emits certain sounds due to the shifting and collapse of the internal snow structure. It is hoped that the analysis of such noise emissions from a snowpack will improve the accuracy of avalanche forecasts in heavily used mountain areas.

Blowing snow

Snow management problems are not unique to the mountains. A newly constructed 77-mile section of Interstate 80, between Laramie and Walcott in southeastern Wyoming, was opened to traffic in October of 1970. Keeping it open in winter became an immediate challenge. Wyoming's high plains are characterized by strong winds and low, sparse vegetation. Snow transported by these winds resulted in large drifts and ice accumulating on the highway and poor visibility for motorists.

The cost of removing snow to keep I-80 open during the winter proved excessive. The Wyoming Highway Department (WHD), with hopes of finding answers to this problem, contacted the Rocky Mountain Station's Snow Management Research Project at Laramie. For several years researchers at the lab had been experimenting with snow fences to control blowing snow. This research resulted in new design techniques to make snow fences more efficient and economical than earlier methods.

Using these techniques, Ron Tabler, leader for the Laramie project, and Bob Jairell, research technician, designed a system of snow fences for the most critical locations along the highway.

During the next two years the WHD erected over 60,000 feet of 12-foot-high fences along I-80. By the winter of 1973-74, a total of 17.06 miles of the highway were protected at a total cost of $1.5 million.

The fences made a dramatic difference. Most of the blowing snow was trapped before it reached the highway. Plowing was virtually eliminated along the fence sites. In addition, visibility in the lee of the fences was greatly improved during ground blizzards. A 1975 cost analysis study showed the fences cut snow removal costs in half, an annual savings of $80,000, based on the 1975 dollar value. At this rate, savings in snow removal alone will pay for the fences in about 15 years. In addition, there was a 15 percent reduction in accidents and a 30 percent reduction in damage costs.

This 12-foot tall fence is designed to withstand over 100 mph winds and remain in service for about 25 years.

Although this snow fence system has been of great benefit to all involved, blowing snow still occurs along I-80, and at times severe conditions reduce visibility to the point that the highway must be closed altogether.

The Laramie and Fort Collins projects worked together to develop a "visual range monitoring system." Part of this system is an electronic snow particle counter that measures the size and number of particles transported by wind at a given point and time. With this instrument, and an anemometer, it was possible to develop a technique for estimating the visibility motorists might experience during blowing snow conditions.

Snow is removed from a trouble spot prior to fence installation (L). With fences, the same spot is clear, even at times of peak accumulation.

The WHD has put this research to good use in developing a "road condition monitoring system" that gathers information from strategically located weather instruments and relays it to the WHD. These data are recorded continuously on chart recorders and analyzed by computer to help make traffic regulation decisions. Warnings to motorists can then be displayed on variable message electric signs. This unique system warns motorists of icy roads, blowing snow conditions, safe driving speeds, driving time to the next town, and alternate routes of travel should conditions warrant closure of this section of I-80.

R. A. Schmidt, research hydrologist, checks particle counter (L) that relays blowing snow data to a WHD computer for visibility analysis. This information is then made available to motorists, on variable message signs.

Experience gained from the research and application of new fencing techniques along Wyoming's I-80 is being used in other states for help in managing blowing snow.

Other accomplishments

Snow research at the Rocky Mountain Station has played an important role in other areas, too. For example:

— The two projects recently helped a pipeline company assess the feasibility of using fences to trap blowing snow for a road base, thereby keeping equipment off the fragile Alaskan tundra.

— New methods for highway design have been developed to help keep them free from drifting snow.

— New techniques have been applied to trap blowing snow and improve the availability of water for livestock and irrigation — a commodity of increasing importance in the drought-stricken West.

— Snow fences have been used in several western ski areas to trap and hold blowing snow on ski slopes, and to reduce avalanches by keeping snow off hazardous slopes.

Continued research, along with cooperation from private and public organizations, will help man better cope with snow management problems and use snow to his benefit.

Readers requesting additional information on blowing snow research at the Rocky Mountain Station should contact Ron Tabler at Laramie, Wyoming, (307) 742-6621, FTS operator — 328-1110.

For additional information on avalanche research, call Mario Martinelli, Jr., at Fort Collins, Colorado, (303) 482-7332, FTS — 323-1207.

Publications available from the Rocky Mountain Station describing these and related studies in greater detail include:

Judson, Arthur, and Bernard J. Erickson. 1973. Predicting Avalanche Intensity from Weather Data: A Statistical Analysis. USDA Forest Service Research Paper RM-112-FR12, 12 p.

Judson, Arthur. 1975. Avalanche Warnings: Content and Dissemination. USDA Forest Service Research Note RM-291-FR12, 8 p.

Judson, Arthur. 1976. Colorado's Avalanche Warning Program. From Weatherwise, Vol. 29, No. 6, December 1976, 10 p.

Leaf, Charles F., and M. Martinelli, Jr. 1977. Avalanche Dynamics: Engineering Applications for Land Use Planning. USDA Forest Service Research Paper RM-183-FR12, 51 p.

Martinelli, M., Jr. 1974. Snow Avalanche Sites: Their Identification and Evaluation. USDA Agriculture Information Bulletin 360-FR12, 27 p.

McNair, Donald, and Frank Wolfe, Jr. 1977. An Acoustic Emissions Monitoring System for Avalanche Snowpacks. USDA Forest Service Research Note. RM-340-FR12, 4 p.

Perla, Ronald I., and M. Martinelli, Jr. 1976. Avalanche Handbook. USDA Forest Service Agriculture Handbook 489, 238 p. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402, Price $3.95. Request Stock No. 001-000-03466-9/Catalog No. A1.76:489.

Tabler, Ronald D. 1973. Snow Fences Improve Highway Safety. Pub. Works 104(8):74-75.

Tabler Ronald D. 1973. New Snow Fence Design Controls Drifts, Improves Visibility, Reduces Road Ice. From the Annual Transportation Engineering Conference (Denver, Colorado, February 1973) Proceedings 46:16-27.

Tabler, Ronald D. 1974. New Engineering Criteria for Snow Fence Systems. From Transp. Res. Rec. 506, p. 65-78. NAS-NRC, Washington, D.C.

Tabler, Ronald D. 1975. Predicting Profiles of Snowdrifts in Topographic Catchments. From the Western Snow Conference Proceedings (Coronado, California, April, 1975) Proceedings 43, p. 87-97.

Tabler, Ronald D. 1975. Estimating the Transport and Evaporation of Blowing Snow. From the Snow Management on the Great Plains Symposium (Bismarck, North Dakota, July, 1975) Great Plains Agricultural Council Publication 73, 186 p.

—By Rick Fletcher, Rocky Mountain Station

Scientists create a model tussock moth outbreak

When the next outbreak of the Douglas-fir tussock moth rolls around, forest managers in the western United States will have a sophisticated new tool — a computerized crystal ball — to help them make decisions about what, if anything, should be done to control the moth.

When the most recent of the periodic outbreaks of this defoliating insect occurred in the western United States in 1971-74, professional foresters had no systematic basis for reconciling the differing predictions from experts about the probable duration of the outbreak and the amount of damage it would cause. Because of heavy defoliation in some areas, and land managers' concern about additional damage, thousands of acres of western conifer forests were sprayed with DDT.

The computerized crystal ball is really three computer models that will be used to integrate knowledge about the Douglas-fir tussock moth and forecast the effects of an outbreak on tree stands and watersheds. The models are one of the products of the expanded Douglas-fir Tussock Moth Research and Development Program, established in late 1974 to help find new answers to the tussock moth problem.

Three principal models — the Stand Prognosis Model, the Stand-Outbreak Model, and the Socio-economic Model — will be ready for testing by the time the research and development program concludes in September 1978. The Stand Prognosis Model is actually a series of regional models structured to describe host-type timber stands throughout the range of the tussock moth. These models will process accumulated information on the progressive condition of stands, assuming "normal" growth rates and planned timber harvest. The Stand Outbreak Model will project the interaction between stand characteristics at the start of an outbreak, behavior of the insect during the outbreak, and methods for control. The Socio-economic model deals with several kinds of costs, for example, the cost of artificial control methods if those are employed, and the costs of the outbreak to timber, water, wildlife, and recreation values.

A model is a formula for predicting what is likely to happen — given certain circumstances — on the basis of what has happened in the past. It is a substitute for an expert who might keep all relevant knowledge constantly in mind and apply it in the correct sequence to forecast a result. For example, an ideal tussock moth outbreak expert would be able to look at a sample of moth larvae, appraise the condition of the timber stand the sample came from, and predict the progress of the outbreak and the amount of damage over the duration of the outbreak. He would not only have comprehensive knowledge about the insect and the impact of past outbreaks on timber stands, but he could also make the lightning fast calculations of a computer.

Two sides of a cross section from a sample tree will be cut away in preparation for gathering growth data for the Normal Stand Model for a timber stand.

Robert Monserud, an associate of model-maker Albert Stage, Intermountain Station, Moscow, Idaho, and Research Technician Jonalea Tonn examine a groove cut into the rectangular slab to make the growth rings stand out sharply.

Data on natural tree growth is an example of information collected in the field and laboratory to form the basis for models.

The ideal tussock moth expert exists — not as one person but as a team of scientists and mathematicians skilled in the use of computers. Entomologists who have studied the insect's structure, physiology, and behavior for many years are pooling the knowledge they have accumulated in the laboratory and forest. A skilled modeler is working with the entomologists to condense their knowledge into its essential relationships and produce a mathematical structure that duplicates the processes of a real outbreak. Scott Overton, professor of forest biometrics at Oregon State University in Corvallis, Oregon, is the mathematician-modeler for the Stand-Outbreak Model. He and several colleagues are structuring the equations of the model and translating them into mathematical instructions so the thousands of calculations required to project all possible outcomes of a real outbreak can be made by the computer and printed out for the decision-maker. Overton describes modeling as "placing a mathematical structure on knowledge."

The grooved slab is placed on an optical scanner which can be operated to read the width of the growth rings and feed the information to a key puncher. Each ring width is recorded on a card. Together the cards tell the complete growth history of the sample tree.

The essential process in the model, as in a real outbreak, is the amount of defoliation the insect will cause under given conditions. When an outbreak is recognized, probably from a spring survey of larval hatch, the forest manager will furnish certain information concerning the species mixture of the affected stand, habitat community type, age or size of trees, foliage composition, and the larval counts. Given this information, the forest manager can request a computer run to predict the estimated damage.

The working model

The following information from the Stand-Outbreak Model illustrates the way models work. Equations translate the development and feeding behavior of the insect into the amount of defoliation the insect will cause in each life stage, and during each year of the course of the outbreak. For example, one equation represents the effect of a given number of larvae on a typical tree branch. This equation takes into account the amount of food each larva must eat to pass through its developmental stages and the amount it destroys but does not consume. Newly hatched larvae feed on the underside of new needles, often taking a single bite from each needle — enough to put the needle out of business but not doing very much to fill up the growing larvae. The amount of foliage damaged varies with the species of tree and the age of the larvae. Newly hatched larvae require new needles for food, but as they get older they can feed on older needles. However, this relationship varies with the geographic region and the density of the larval population. These few facts suggest the enormous detail and variations that are built into the equations of the Stand-Outbreak Model.

Estimates of the amount of top kill, tree mortality, and growth loss are based on projected patterns of defoliation in the affected stand if natural controls take their course. These natural controls include birds which eat both larvae and pupae, and other organisms — such as insect predators, parasites, and diseases. These factors presumably have controlled moth populations for thousands of years — but not before some defoliation has occurred, and occasionally significant damage, as in 1971-74.

The effects on the outbreak of direct controls, such as aerial sprays of natural microbial materials and chemicals, are included by specifying the insect mortality expected from available control programs. In cases where natural controls are affected by direct control methods, these factors are also specified.

The Stand-Outbreak Model is constructed to forecast the effects over the duration of a typical outbreak, plus three post-outbreak years. "It is important to realize that the model cannot predict outbreaks," says Overton. "It can only forecast the course of an identified outbreak."

The condition of the affected stand at the end of the outbreak can then be incorporated into the Normal Stand Model. Some of these models have already been built to describe stands in western National Forests. They are based on prognosis methods developed by Albert Stage of the Intermountain Station, who is in charge of this phase of modeling.

The third major model is the Socioeconomic Model, which is being developed under the leadership of Gerard Schreuder, professor of forest economics, and Director of the College of Forest Resources at the University of Washington in Seattle. This model will contain equations to project the costs of all possible outcomes of an outbreak and ways of dealing with it. Among these costs are the effects of defoliation on timber growth and mortality, fish, wildlife, water, and recreation, as well as the costs for purchase and application of control materials.

The final product from the three models will be a series of estimates of the results and costs of each course of action that might be taken regarding an outbreak.

A sound tool

Entomologist Bob Campbell of the Pacific Northwest Station's Corvallis Laboratory

serves the Tussock Moth Program as leader of the Integration Working Group. This group is responsible for putting both old and newly-developed information into a pest management system. Regarding the models, he says,"Although they are imperfect in some details, they form a conceptually sound tool which is flexible and based on data from the forest manager's local area. The models are based on more than 20 years of basic research on both the pest and its impact on forests."

When the next outbreak occurs the family of models will be available for trial. They will be operated by the Methods Application Group at Davis, California. The purpose of this group, part of the Forest Service's Insect and Disease Management Staff, is to develop, test, and make available methods and technology for dealing with insect and disease management problems in western forests.

When the next outbreak threatens, the forest manager will be able to ask for projections, based on the larval sample and characteristics of his stand, to forecast the outcome of all the options he wishes to consider. These forecasts will list the losses the manager can expect in timber mortality and growth over a rotation, as well as losses to recreation, wildlife, fish habitat, and water quality. Perhaps the cost of all available artificial controls will be greater than the anticipated loss in forest values. The forest manager may even discover that the projected timber losses are about the same as what he plans to harvest and decide to adjust his harvest plan and save the cost of control.

The computer print-outs will not make decisions. The consequences of the options will still have to be weighed, but, the models and the vast store of information they represent will provide sound biological and economic bases for making decisions.

As additional knowledge is discovered by scientists after the expanded 4-year program concludes, succeeding generations of models will update and refine the modeling process. However, an operational model will remain available at Davis.

Some day researchers may discover what triggers a population increase of the Douglas-fir tussock moth every 7 or 8 years, and outbreaks may be prevented. Until that time, scientists, speaking through the family of computer models, will provide coordinated, scientific projections on which forest managers can base their decisions.

Information about these models may be obtained from Ken Wright, manager of the Douglas-fir Tussock Moth Program, at the Pacific Northwest Station — (503) 234-3361, FTS-429-4918.

— By Dorothy Bergstrom, Pacific Northwest Station

Aquatic habitat study begins

What influence does livestock grazing along the high mountain meadow streams of the Idaho Batholith have on fish and aquatic habitat?

William S. Platts, fisheries biologist at the Intermountain Station's Boise laboratory, is in charge of new studies that will provide reliable answers to the question. The research will be conducted within the Boise and Sawtooth National Forests on 10 sites characteristic of Idaho Batholith meadow ecosystems.

Platts and his coworkers will evaluate stream channels and banks and streamside environment during the grazing season. They will document natural changes in streamflow and identify how different grazing systems affect fish populations and the aquatic and streamside vegetation. They will also determine if fish cover and bank stability can be maintained or improved with alternative grazing systems.

Publications

Aspen management

Quaking aspen is an important wildlife food in the Southwest. It is available during most of the year, and provides needed protein for deer and elk when other plants are unavailable or are low in nutrient value. Although some clones produce enormous numbers of tiny seeds, aspen reproduction in the Southwest is mostly by sprouting from roots.

Ninety-three percent of the existing aspen stands in the Southwest are mature or overmature, and do not have large numbers of sprouts. A recent report discusses factors that affect the regeneration and management of the tree. Aspen does not usually form large stands in the Southwest; small aspen patches are generally associated with larger stands of conifers. The report suggests that because of this characteristic, management of aspen for deer and elk should be aimed at providing large amounts of leaves and twigs for food. Nearby conifers will provide needed cover. The report states that unless stands are regenerated by cutting or burning to enhance sprout growth, aspen acreage in Arizona and New Mexico will gradually decline.

Copies of "Managing Aspen for Wildlife in the Southwest," General Technical Report RM-37-FR12, by David R. Patton and John R. Jones, are available upon request from the Rocky Mountain Station.

Producing trees and elk

Trees and elk are renewable resources which occupy many of the same areas throughout the western United States. Evidence shows that both can be produced in the same area. Information about the effects of human activity on elk behavior can help land managers make full utilization of the land without losing the wildlife resource.

A recent report describes the results of a 4-year study of elk behavior in relation to timber harvesting and forest road traffic. Radiotelemetry, time-lapse photography, and counts of elk tracks on roads were used to assess elk behavior in relation to timber harvest activities on the Medicine Bow Range in south-central Wyoming. Results show that elk preferred to stay at least 800 meters (½ mile) from people engaged in timber harvest or clean-up operations. Elk move back to the harvested areas soon after human activity, especially that beyond 400 meters (¼ mile) from the road. Most road crossings by elk were made where desirable feeding sites, such as clearcuts and natural openings occurred near the road.

More information on this study can be found in "Elk Behavior in Relation to Timber Harvest Operations and Traffic on the Medicine Bow Range in South-Central Wyoming", by A. Lorin Ward, a reprint from the Elk — Logging — Roads Symposium Proceedings, held December, 1976 at the University of Idaho at Moscow, Idaho. Copies are available from the Rocky Mountain Station.

Dwarf mistletoe spread studied

Dwarf mistletoe that is infecting otherwise-healthy young red or white firs may spread so slowly that it will not seriously affect the trees until their height growth slows down at maturity, a California study shows. Plant Pathologists Robert F. Scharpf of the Pacific Southwest Station, Berkeley, and John R. Parmeter, Jr., of the University of California, Berkeley, conducted the study to learn how fast dwarf mistletoe builds up and spreads through the crowns of true firs that are not exposed to infected overstory trees. They reasoned that this rate of spread, in relation to tree height growth, could be used to predict future levels of infection and impact on tree vigor.

For the experiment, they located 26 young firs that were out of the range of any overstory source of mistletoe infection, and inoculated them with dwarf mistletoe seeds. These trees ranged from 5 to 32 feet in height, and were located on sites in the southern Cascades and central Sierra Nevada.

The study results, based on examinations of the trees during a 12- to 15-year period following the inoculation, showed that dwarf mistletoe spread from the original site of infection to new infection sites further up in the crown at an average rate of only 3 inches per year, or less. All of the test trees grew in height several times faster than the parasite spread.

The researchers say these results suggest that dwarf mistletoe will have little impact on young-growth firs, growing on good sites free from exposure to infected overstory trees, if the young-growth stands are "managed for optimum height growth consistent with other management considerations."

Details are in Research Paper PSW-122-FR12, "Population Buildup and Vertical Spread of Dwarf Mistletoe on Young Red and White Firs in California." Copies are available from the Pacific Southwest Station.

New soil core sampler

Collecting soil samples from steep, rocky sites has always been a tough problem — too many rocks make digging impractical, and the terrain may prevent the use of heavy, power-driven equipment.

M. F. Jurgensen, Michigan Technological University, Houghton; M. J. Larsen, Forest Products Laboratory, Madison, Wisconsin; and A. E. Harvey, Intermountain Station, have developed a device that solves many of the problems — a portable, hand-operated soil core sampler. It provides a 4- by 11.8-inch soil core and can be built by most machine shops.

Called the "Thumper," the sampler has two basic units — a soil-coring cylinder, and a combination cylinder driver and soil core extractor. Two people can operate the device, and it is designed so that it can be taken apart and carried in a backpack.

Harvey, a plant pathologist at the Intermountain Station's Forestry Sciences Laboratory, Missoula, needed over 2,000 soil samples for a study on the environmental effects of timber harvesting on steep, rocky sites in western Montana. "It was a matter of trial and error," Harvey says, "but we finally got a sampler that worked."

The sampler is described in "A Soil Sampler for Steep, Rocky Sites," INT-RN-217-FR12, written by Jurgensen, Larsen, and Harvey. Copies are available from the Intermountain Station.

How long will they stand?

Before a forest fire is "dead out," land managers begin planning for the future of standing snags left in the aftermath. Pulpwood, house logs, firewood, and wildlife habitat are among the alternative uses. One of the most pressing questions is, "How much time do we have before the snags go down?"

As part of a study of postfire vegetal succession on the Sleeping Child Burn, Bitterroot National Forest, Montana, L. Jack Lyon, Intermountain Station wildlife biologist, examined snag attrition. He periodically counted the number of standing lodgepole pine snags on eight transects within the 28,000-acre burn. Initial data were taken one year after the fire in 1962; counts were repeated in 1963, 1966, 1969, 1971, and 1976.

Following two years with little windthrow, snags on this burn fell at an annual rate of 13.4 percent. At current rates, most of the snags will fall within the next 40 years. A few larger snags, less susceptible to windthrow, will stand indefinitely.

Details of Lyon's study are available in "Attrition of Lodgepole Pine Snags on the Sleeping Child Burn, Montana," INT-RN-219-FR12. Write to the Intermountain Station for a copy.

Habitat requirements for deer and elk

Guidelines to help land managers and resource planners evaluate the consequences for deer and elk of timber management activities in the Blue Mountains of eastern Oregon and Washington are outlined in a recent publication from the Pacific Northwest Station. The essential integrating factor in considering habitat for Rocky Mountain elk and Rocky Mountain mule deer in timber management planning is the ratio of cover to forage areas. The optimum ratio is estimated as 40-percent cover to 60-percent forage areas, although the sizes of cover patches and forage areas, and their location in relation to each other, must meet certain requirements.

A series of tips for enhancing deer and elk habitat, while producing timber, are offered. The publication concerns habitat management in the Blue Mountains, but the principles of management apply to other parts of the West.

The paper is the result of a cooperative effort by the State Departments of game in Oregon, Washington, and Idaho, the U.S. Bureau of Land Management, and the U.S. Forest Service and was presented at the Elk-Logging-Roads Symposium held at Moscow, Idaho, December 1975. Reprints of "Relationships of Rocky Mountain Elk and Rocky Mountain Mule Deer Habitat to Timber Management in the Blue Mountains of Oregon and Washington," by Hugh Black, Richard J. Scherzinger, and Jack Ward Thomas are available from the Pacific Northwest Station.

Graphs by computer

Graphs drawn by a plotter attachment to a computer can be used directly in publications, under a program used at the Pacific Northwest Station. Computer-drawn graphs have two principal advantages over hand-drawn graphs: they are more accurate and take only minutes to prepare instead of hours. By following requirements for submitting data, a scientist can dispense with the chore of plotting

his own graphs and also save many hours for the illustrator.

A program which produces graphs of good quality that require very little additional preparation before publication was developed by Mensurationist Don DeMars in 1973 for use with the Wang 700 Series Calculator and has been used to produce graphs for many publications since that time. DeMars and Illustrator Delbert Thompson expect that in the future most manuscript graphs will be drawn by computer.

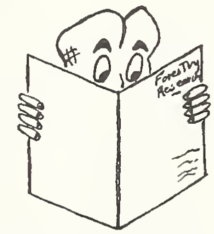
The format for plotting data can be used with all types of computers that have plotting capability. In addition to producing graphs for publications, the system developed by DeMars can assist forest managers and scientists in their daily work by spotting errors in collecting data and plotting equations.

The requirements for submitting data have been outlined in "Computer Plotting of Graphs for Reports," Research Note PNW-289, by Donald J. DeMars and Delbert E. Thompson. The publication is divided into three main sections: 1) plotting data requirements regardless of the type of graph used; 2) graph types and their individual requirements, and 3) special plotting techniques. Copies are available from the Pacific Northwest Station.

Water makes firelines

A simple technique for installing firelines before prescribed burning of light rangeland fuels utilizes plain water and standard firefighting-equipment. Pickup pumpers are used to apply water through two 4-foot wands attached to a Y. Backpack pumps are also used to apply water. The process is rapid, effective, and does not permanently disturb the landscape. Costs are low.

Three variations of the technique are described in a recent publication, "Wetline Technique for Prescribed Burning Firelines in Rangeland," Research Note PNW-292, by Robert E. Martin, Stuart E. Coleman, and Arlen H. Johnson. Copies are available from the Pacific Northwest Station.



You'll find lots of good reading in the January issue. Feature articles will cover: Forest Genetics; Habitat Needs of Woodpeckers; Forest Insect Research; and more.

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